

# **PLANNING TO REMEMBER: INNOVATION AND INHERITANCE IN THE DESIGN OF A MOON/MARS SPACECRAFT**

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# How Do Institutions Remember?

- This talk is about the institutional memory involved in building a new spacecraft
- It fits within a larger set of questions about institutional memory:
  - Do institutions remember?
  - If they do, what do they remember with?

# **Do Institutions Remember?**

- Clearly not in the neurological sense
- But institutions do manage to preserve and use representations of the past to guide present and future actions
- Daly, Fentress and Wickham, etc.

# What Do Institutions Use To Remember?

- **Records:**  
paper and digital



- **Stories: Oral and written**

“There’s a story about Wernher Von Braun ...”



Records of Shuttle Repair in “coffins” at Kennedy Space Center

# What Do Institutions Use to Remember?

- Material constructions
  - Objects
  - Infrastructure



Shuttle in KSC High Bay for Refitting

- Practices



Drawings by astronauts' children during launch

# **NASA's Spacefaring Plans:**

## **President's Space Vision - 1/14/04**

- Develop & test a new spacecraft, Crew Exploration Vehicle
  - Unmanned flight by 2008,
  - First manned mission no later than 2014, carrying astronauts beyond our orbit to other worlds.
- Return to the moon by 2020, as launching point for missions beyond.
  - By 2008, robotic missions to the lunar surface to research and prepare for future human exploration.
  - Human missions to the moon as early as 2015
- Next steps of space exploration: human missions to Mars and to worlds beyond.

# History of Design Efforts: Planned Successors of the Shuttle

- Experimental Space Planes:
  - X-33, X-34, X-37
- Orbital Space Plane: Space Bus to the Shuttle
- Crew Exploration Vehicle
  - First design round for National Space Vision
- Current Apollo-like architecture
  - Crew vehicle docks with lunar lander in space



Artist's Concept: Lunar Lander Launch, Crew Launch, Crew and Lander Dock and Depart for the Moon

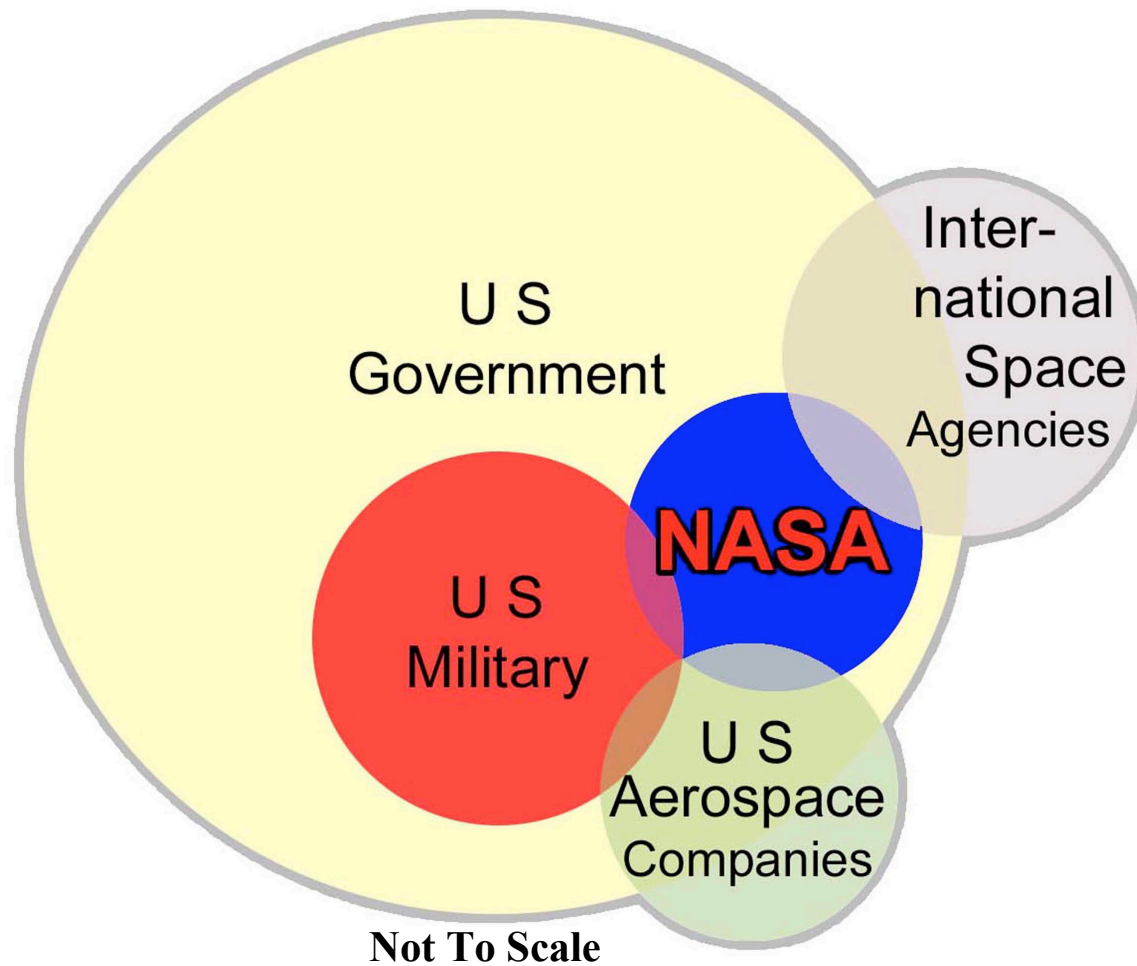
# **An Anthropologist (Working) On Mars:How I'm Involved**

- As part of this effort, I have been a member of two spaceship planning teams
  - Orbital Space Plane Requirements Team
    - An earlier design effort
    - I helped to design and evaluate requirements in the areas of knowledge management, training, the human side
  - NASA Ames Crew Exploration Vehicle Team
    - First iteration of National Space Vision plans
    - Team developing NASA partnerships with industry
    - I represented the area of knowledge management, particularly in Integrated Vehicle Health Management Systems

# Design and Memory

- Spaceship design is an ideal location to study the role of material objects in institutional remembering
- Any spaceship design draws heavily on previous designs
  - Engineering conservatism: stick with designs that you know have worked
  - Financial conservatism: aerospace corporations have an interest in selling what they already have in the pipeline

# The System of AeroSpace: Who Builds a Spacecraft



# Memory Issues in Spacecraft Design

- Where does institutional memory reside?
  - Complex collaboration between NASA, aerospace companies, international partners
- Time scale
  - These are “generational missions”
  - How to pass knowledge from departing experts to their replacements (or database it)
- Issue of documentation
  - What must contractors document?
    - Depends on how the contracts are written
  - Long term storage of archives, particularly for terminated projects

# Procurement Model & Design Process

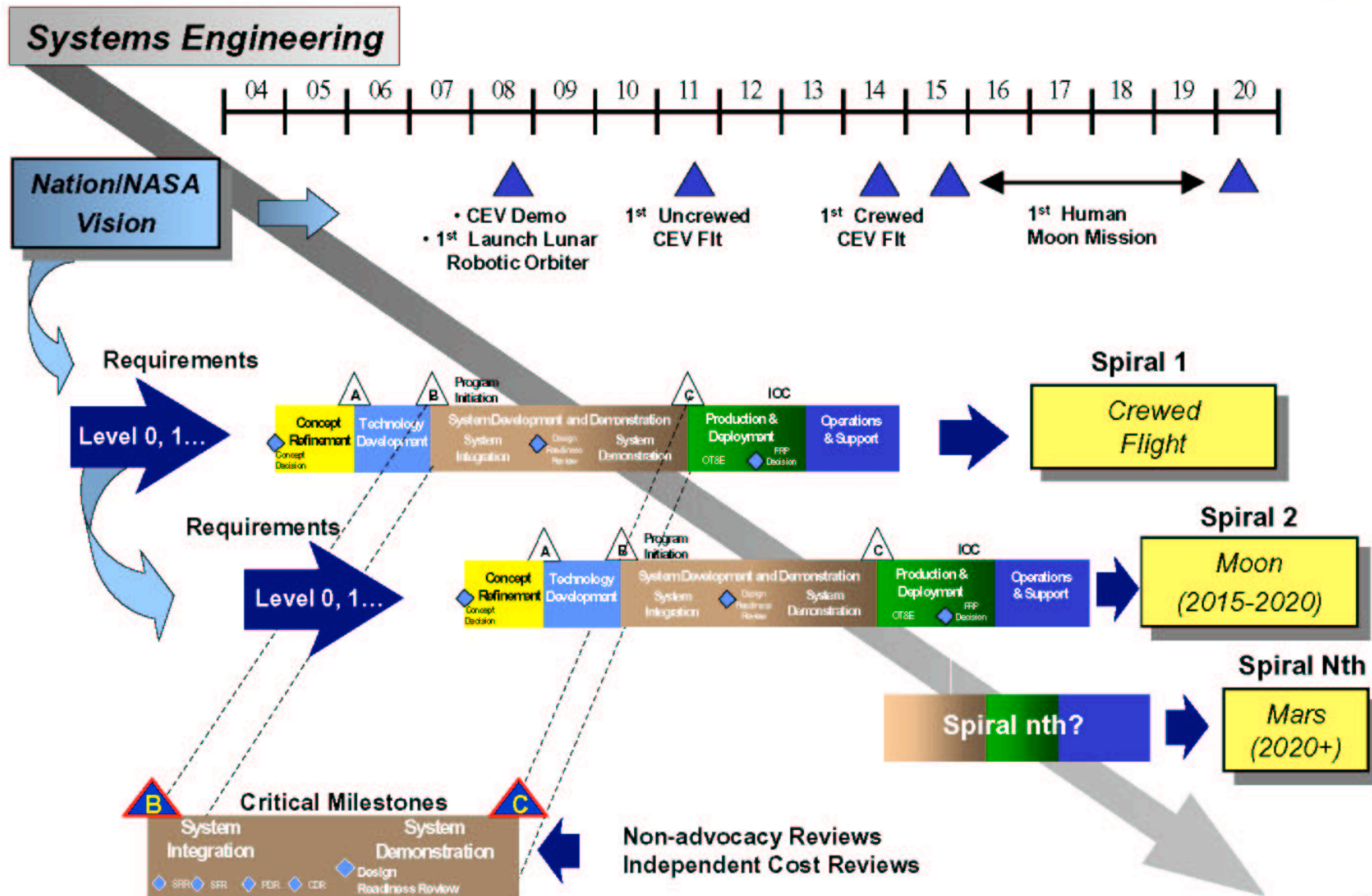
- Procurement Model Issues
  - How detailed is the Request For Proposal?
    - Functional requirements leave design decisions to contractors
    - Technically detailed requirements come from design decisions in-house at NASA
    - Historically a tension between NASA and the aerospace companies
  - Alternate Structures for the Competitive Process
    - Open Competition
    - Downselect to two competitors with flyoff
    - “Third rail” funding for non-traditional aerospace firms
    - Directed funding
- All of these affect which institution is the primary carrier of design memory

# Time Scale and Memory

- Moon, Mars and Beyond is a multi-decade plan
  - Can not make detailed plans for technology not yet developed
  - Plan includes “spiral development” – essentially planning to plan
    - Cyclical approach: design spiral allows for feedback and learning
    - Initially a software development method
    - Adapted by DoD as part of its evolutionary acquisition strategy to get newer technologies into large platforms, such as assault vehicles and computer systems, much more quickly.

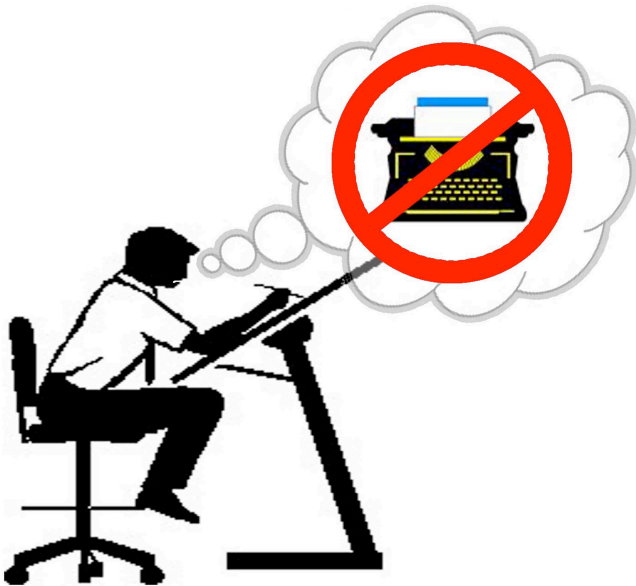


# Project Constellation (Crew Exploration Vehicle)



# Problems of Long-term Planning

- No one wants to be responsible for the next Y2K problem
  - Obvious design flaw that could have been anticipated
- More thoughtful designers don't want to be responsible for the next QWERTY keyboard
  - A good solution for its time
  - Could be improved or replaced once new keyboard technologies are designed
  - Problem is social: an installed base of users can not be forced to switch to a better design when the technology changes



# Conclusion: Studying the Accretion of Memory

- Design is a powerful carrier of memory
- Time involved allows for easier study
  - This is the *longue durée* of technology
- Complex interaction of technical, political and societal factors
- Spaceships are expensive, complex, beloved, and cool